Sprinkler System Design and Use

A sprinkler system is a collection of component devices which, powered by a pump, transports water from either groundwater or surface water (e.g., a small man-made reservoir, or a natural water body like a pond, stream or lake) that projects water into the air and deposits it onto the surface of the ground. It consists of metal or plastic pipes, which are either horizontal (mains, submains, and laterals) or vertical (risers), and rotating sprinkler heads, made mostly of metal, with nozzles mounted in them. The horizontal pipes are typically buried under the surface. There are also a number of other parts including fittings, valves, vents, filters, etc.

Purchasing and accepting a design of a sprinkler system are probably some of the most important decisions that a cranberry grower will make. Before designing a system, examine the water source to be sure that it is of acceptable quantity and quality. One should consider the wide range of present and future water needs when deciding on pump specifications, capabilities, and location, as well as the traits of all the components to be sure that they will function in a compatible and integrated manner. The design of the system should avoid excessive water velocities, and limit the pressure loss due to friction as water moves through the system. An irrigation system will only perform well if it is engineered correctly and is properly operated and maintained.

Recommended Practices

Optimize irrigation system performance.

Clean and inspect the irrigation pump annually. Inspect packing, seals, and foot valve of the pump and repair if necessary. Use a filter basket on the intake pipe of your system to prevent foreign objects from damaging the pump impeller and to limit clogging of sprinkler nozzles.

Check mains, lateral lines, and riser gaskets for leaks annually. Lateral lines should extend out to the ditches and cleanout plugs should be installed to allow for flushing of sediment and other debris that accumulates in the lines. Flush out lines in the spring before installation of risers and sprinklers to minimize plugging of lines and sprinklers during the season. Use riser strainers or filters to prevent clogging of nozzles. Sprinklers at the ends of lines are prone to clogging, so installation of a ballcock shutoff valve or in-line strainer will facilitate easier or less frequent clean-out. Avoid scratching the interior of straight bore nozzles when removing a foreign object lodged in the orifice. Use a coated wire or “plastic” wire to remove materials from an obstructed nozzle. Nozzles containing plastic stream straighteners or vanes should not be cleaned out with wire because vanes are easily damaged. Remove the vaned nozzle from the sprinkler and remove the obstruction with needle nose pliers or tweezers. Protect mains and laterals from dents and limit the number of 90° elbows in the system. Dents and elbows can significantly increase friction losses that can result in significant pressure drop across the system.

Perform routine and periodic maintenance to sprinkler heads and risers.

Replace broken or damaged sprinkler heads or head components and worn nozzles. Check for nozzle wear by inserting a drill bit of the appropriate size in the nozzle orifice. A slight increase in the orifice size can have a significant impact on the water delivery rate. A 1/64" expansion will increase water use by about 1 gallon per minute.

A wobbling riser is usually indicative of a worn or leaking gasket or broken coupling. Inspect riser couplings annually and replace worn or broken parts. Leaning risers can have a

significant negative impact on uniform application of water. Straightening and staking risers can dramatically improve uniformity of application.

Sprinklers should rotate at least one revolution per minute if they are to be effective for frost protection.

Replace washer stack, bearing washer, and tension springs when sprinklers turn at less than one revolution per minute. Replace conventional plastic washer stacks with Teflon washer stacks to increase rotation speed of sprinkler heads. Brass arm spoon driven sprinklers should rotate at between 1 and 2 revolutions per minute. Use of brass sprinklers with an aluminum arm is another way to increase rotation speed. Excessive rotation can cause premature wear of the sprinkler components. Aluminum arm sprinklers are more fragile than brass arm sprinklers, so exercise caution when removing and storing them.

System operating pressure should fall within the range of 45 to 60 psi (for solid set sprinklers) with pressure requirements increasing as system spacing increases.

Nozzle pressure at the last or weakest sprinkler head should be no less than 40 psi, and pressure losses across the entire system should be limited to <15% of pressure at the first sprinkler off the main water line. Some pressure loss is expected across a system due to friction and head effects but a large pressure drop across a system suggests leaks in the main or laterals. The nozzle pressure of a sprinkler is measured with a pressure gauge (pitot tube) while the sprinkler is in operation. Operating the system at the low pressure range will result in large water droplets and a distribution of most of the water around the outer edge of the pattern, while operating the system above the pressure range will result in misting and drift. Pressure above 60 psi can cause the sprinkler arm to strike the back of the sprinkler body, causing the sprinkler to stand still or turn backwards.

Consider upgrading or improving your irrigation system if operating pressure at the heads is less than 40 psi for standard solid set sprinkler heads.

Irrigation uniformity may be evaluated by conducting irrigation uniformity catch can tests.

Irrigation system performance should be evaluated on a regular basis (preferably annually) to insure that it is performing satisfactorily. Irrigation system performance can be measured by conducting a uniformity test. Coefficient of Uniformity (CU) of < 70% indicates that a system needs updating and improvement. USDA Natural Resource Conservation Service recommends that you attempt to achieve the ideal of 85% uniformity when designing or improving cranberry irrigation systems. Use the right combination of lateral spacing, operating pressure, sprinkler model, and nozzle type and size to achieve 90% overlap of wetted diameter.

Irrigation uniformity may be improved by the use of high uniformity nozzles, straightening and staking risers, and installing riser extensions so that sprinkler heads extend above the vines. A riser height of at least 18 inches is optimal. When renovating old bogs or installing new bogs choose the smallest sprinkler spacing possible. Uniformity of application decreases as sprinkler spacing increases.

Based on irrigation uniformity tests on bogs in Massachusetts, properly functioning irrigation systems with the following lateral and sprinkler spacing should achieve CU’s in the following ranges. The actual CU will depend on the sprinkler heads used and the running pressure of the system, which will also affect the wetted diameter.

Spacing (ft)	CU(%)
40 x 50	75 - 90
50 x 60	70 - 85
60 x 70	60 - 75

Compare uniformity test results with yield records when evaluating sprinkler system performance.

Use sprinkler heads with one open outlet.

Sprinkler heads with two outlets (front and rear) are available, but do not deliver acceptable performance on cranberry beds.

Measure the rate that water is applied by your irrigation system.

In order for frost protection to be effective, an irrigation system should apply water at a rate of at least 0.1 inches per hour (protection to 24ºF). Most cranberry systems are engineered to provide 0.14 inches per hour to provide a margin for error and protection to approximately 21ºF.

Knowledge of application rate is also necessary to determine how much irrigation water you are applying. Data collected from a irrigation uniformity test can be used to calculate the system's irrigation rate. Modifications can be made by changing operating pressure or nozzle size. Irrigation systems with low CU's are inefficient users of water - they apply more water per unit time than systems with high CU's to insure that at least 0.1 inches per hour of water reach all areas of the bog.

Consult with a professional when re-designing or making significant improvements to the sprinkler system.

Technology and product availability change frequently. New and innovative systems are constantly being developed. Check to make sure you are using the right components to achieve your water management goals.

Use half-heads, partial heads and/or screens to prevent application to non-target areas.

These should be used especially if the irrigation system will be used for chemigation.

If you plan to use your sprinkler system for chemigation, make sure that application will be uniform and safe and that first-to-last head travel times are minimized.

See the Chemigation BMP for more information on safety, calibration, and techniques for chemigation.

For more information:

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Rainbird maintenance manual for Impact Sprinklers.

Reno, L. 1994. **Solid-set sprinkler irrigation systems.** Cranberries Magazine 57(11):6-7.

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Updated by Hilary Sandler and Jack Heywood and reviewed by CCCGA Environmental Committee, 2010.

Sprinkler System Design and Use Checklist

✓ Consult with a professional when re-designing or making significant improvements to the sprinkler system.

✓ Maximize system performance and uniformity.

✓ If using sprinklers for chemigation, familiarize yourself with the Chemigation BMP.